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Ultrafast high harmonics for probing the fastest spin and charge dynamics in magnetic materials

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Ultrafast light based on the high-harmonic up-conversion of femtosecond laser pulses have been successfully employed to access resonantly enhanced magnetic contrast at the Mabsorption edges of the 3d ferromagnets Fe, Co and Ni in a table-top setup. Thus, it has been possible to study element-specific dynamics in magnetic materials at femtosecond time scales in a laboratory environment, providing a wealth of opportunities for a greater fundamental understanding of correlated phenomena in solid-state matter. However, these investigations have so far been limited to linear polarized harmonics, since most techniques by which circular soft x-rays can be generated are highly inefficient reducing the photon flux to a level unfit for scientific applications. Besides presenting key findings of our ultrafast studies on charge and spin dynamics, we introduce a simple setup which allows for the efficient generation of circular harmonics bright enough for XMCD experiments. Our work thus represents a critical advance that enables element-specific imaging and spectroscopy of multiple elements simultaneously in magnetic and other chiral media with very high spatial and temporal resolution on the tabletop.

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